Mark IIIA Simulation Center EMR 6050–Univac 1108 Computer Interface

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The Mark IIIA simulation center is capable of simultaneously simulating two spacecraft and three deep space stations using the Univac 1108 and EMR 6050 computers. The EMR 6050 and the Univac 1108 were interfaced using Bell System 303C modems and a JPL-designed interface adapter. The design of the interface was constrained by two factors: (1) the final location of the Univac 1108 was undetermined at the time of finalization of the interface assembly design, and (2) the EMR 6050 and the Univac 1108 have different word lengths. The hardware and software approaches used to satisfactorily mate the two computers are explained.

I. Introduction

The purpose of this article is to describe the development, capabilities, and operation of the EMR 6050–Univac 1108 interface. This equipment configuration is an assembly of the DSN simulation center (designated the Mark IIIA Simcen), which is located in the SFOF.

The interfacing of the EMR 6050 and the Univac 1108 computers is part of the current development activity that is taking place in the DSN Simcen in preparation for *Mariner* Mars 1971 and *Pioneer F* support. This activity is described in Ref. 1.

The Mark II Simcen configuration was capable of simulating one spacecraft and one DSS. The Simcen computer, the EMR 6050, had minimal spacecraft modeling capability—the bulk of the data being constructed of fixed data values and ramp functions.

The Mark IIIA configuration is capable of simultaneously simulating two separate spacecraft and three DSSs. The Univac 1108 contains command responsive spacecraft mathematical models, which dynamically change spacecraft commutator parameters. The EMR 6050 accesses model parameters from the Univac 1108 and provides

input/output processing, formatting, and control of displays.

The overall design of the interface between the EMR 6050 and the Univac 1108 was constrained by two major factors: (1) the uncertainty of the location of the Univac 1108, and (2) the different word lengths of the two computers. At the time of finalizing the design of the interface assembly, the location of the Univac 1108 was not finalized. To assure that the interface assembly would be compatible with the location of the Univac 1108, the interface was designed using Bell System 303C modems to provide the coupling between the interface assembly and the Univac 1108.

The different word lengths of the computers provided a constraining influence on the interface assembly design, since the data could not be exchanged on a word for word basis. The methods used to provide a satisfactory mating of the computers are described herein.

II. Description

The general configuration of the EMR 6050–Univac 1108 interface is shown in Fig. 1. The interface assembly was designed and implemented at JPL. The Bell System 303C modems provide the coupling between the interface assembly and the 1108. The interface assembly is connected to the EMR 6050 through a buffered input/output channel. An interface assembly block diagram is shown in Fig. 2. The interface assembly consists of a 24-bit data register, two 8-bit shift registers (one input and one output register), parity generation and detection, failure detection, timing, and control logic.

A. Word Formats

The word length is 24 bits in the 6050 computer and 36 bits in the 1108 computer. Since the computer word lengths are different and since the computers are coupled via modems, which are serial transmission devices, a parallel transfer of information on a word for word basis is not feasible. Instead, the information is processed in 6-bit bytes.

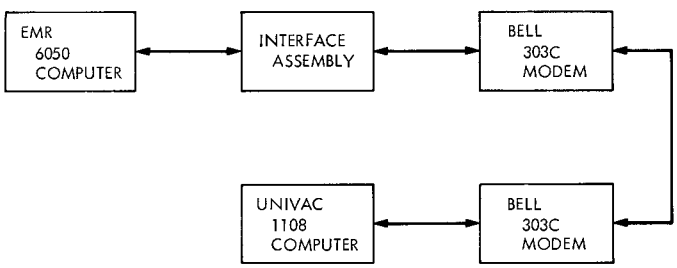

Fig. 1. EMR 6050–Univac 1108 interface configuration

B. EMR 6050 to Univac 1108 Format

The 6050 word format in its standard form and processed for transmission to the 1108 is shown in Fig. 3. The 24 bits are divided into four 6-bit bytes. The interface assembly adds two additional bits to each 6-bit byte. The two bits are a control bit C and a parity bit P. A zero "0" in the control bit position signifies that the byte is a control byte, whereas a one "1" signifies that the byte is a data byte. The parity generator generates even parity for the 8-bit byte.

The words are then transmitted in this 8-bit format least significant bit of the least significant byte first, which results in an unpacked 1108 word.

C. Univac 1108 to EMR 6050 Format

The words transmitted from the 1108 to the 6050 are transmitted in the same 8-bit format. The function and use of the control and parity bits are exactly the same.

The control and parity bits are stripped off of the word in the interface assembly, yielding a 6-bit byte. These 6-bit bytes are packed four to a 6050 word; therefore, $4n$ bytes of data must be sent to the 6050 from the 1108, since the 6050 requires a completely filled word.

D. Control Bytes

Transmission of data between the two computers is activated by the START control bytes, and ended by the STOP control byte. The START control bytes consist of two sync codes (26_8, 26_8) and the STOP control byte consists of one end-of-text (ETX) code (03_8). These control bytes are illustrated in Fig. 4 in the packed 6050 word format. These bytes are stripped off of the data messages in the interface assembly for messages going to the 6050. The communications terminal module in the 1108 performs the same function for messages going to the 1108.

E. Error Detection

Five error conditions are detected and indicated by the interface assembly. These conditions are: (1) collision, (2) parity, (3) data set, (4) underflow, and (5) overflow. These error conditions cause an interrupt to be set in the computer. The response of the system to this interrupt is explained in *Subsection F.*

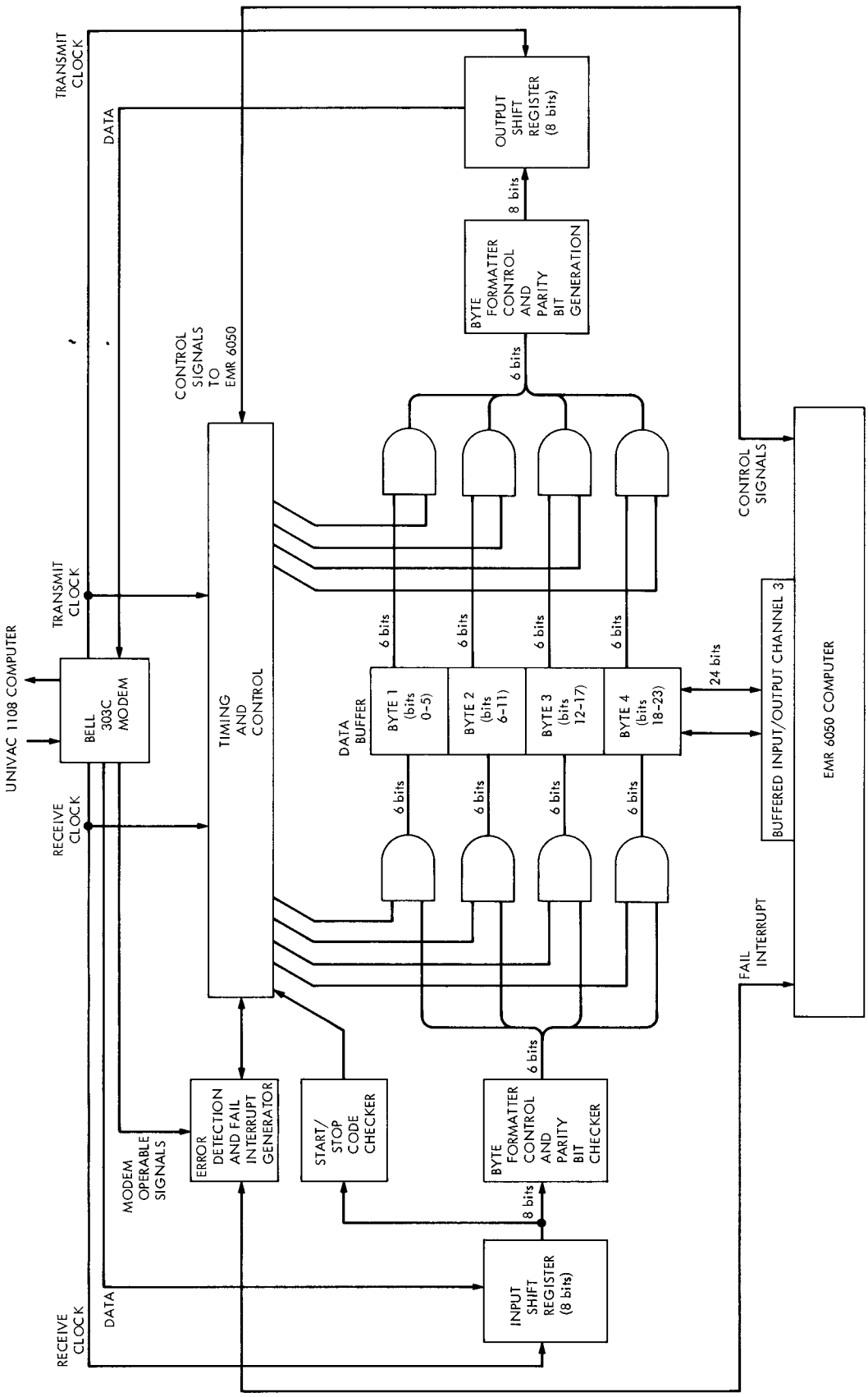

Fig. 2. Interface assembly block diagram

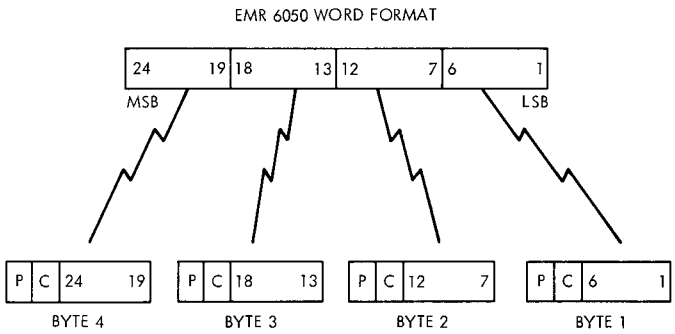

Fig. 3. EMR 6050–Univac 1108 word format

1. Collision. The collision error condition arises when an attempt is made to transmit data to the 6050 by the 1108 during the time that data is being transmitted to the 1108 by the 6050.

2. Parity. The parity error message arises when incorrect parity exists in the message received at the interface assembly from the 1108.

3. Data set. The data set error message arises when the 6050 attempts to transmit data to the 1108 at a time when:

(1) The DATA SET READY signal from the modem is false, indicating that the modem is in the test mode.

(2) The AGC (automatic gain control) LOCK signal from the modem is false, indicating noisy data transmission conditions.

(3) The modem fails to respond to a SEND REQUEST from the 6050 by not setting CLEAR TO SEND true.

4. Underflow. The underflow error message arises when the number of words transferred to the 6050 is less than the number expected, i.e., the number determined by the setting of the memory address and limit registers in the 6050 buffered channel.

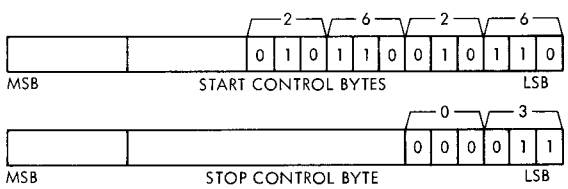

Fig. 4. EMR 6050 START, STOP control bytes

5. Overflow. The overflow error message arises when the number of words transferred to the 6050 is greater than the number expected.

F. Trap or Normal Mode

The interface operates in either the trap or normal mode, the choice of which is determined by a switch on the front panel of the interface assembly. In the normal mode, if an error is detected, the error interrupt is initiated, and as soon as a response is received from the computer, the error flag and the interrupt are reset and the interface is ready for further operation. The cause of the interrupt cannot be determined.

In the trap mode, a detected error causes an interrupt which cannot be reset by the computer. The interface adapter will "hang up," i.e., respond "busy" on this interrupt condition until manually reset by the operator. In this mode, the error condition is stored and indicated on the front panel of the interface assembly. To restore the interface to operation, the mode control switch must be put in normal momentarily.

G. Data Transfer

When a block of data has been completely transferred to the interface assembly or received from the interface assembly, an interrupt is activated in the 6050 to signify the completion of the operation.

H. Communication Sequence

Due to the design of the executive software in the 1108 system, a definite sequence of events must occur when communicating with the 1108. This communication sequence consists of the following information blocks:

(A) "Request to Send" block (6050 → 1108)

(B) Data block (6050 → 1108)

(C) Data block(s) (1108 → 6050)

I. Communication Rules

There must be at least 10 ms between block A and block B. There may be only one block B after an A block.

There may be many C blocks following an A, B sequence. There must be at least one C block before another A block can be sent. All data blocks sent in either direction must be separated by at least 1 ms.

J. Block Formats

The block formats of blocks A, B, and C are illustrated in Fig. 5.

Although the 1108 precedes each C block with two sync codes (26_8, 26_8) and follows each C block with one ETX code (03_8), the hardware will strip these characters off and only data will arrive at the 6050.

If the 1108 user tries to send more than 250 words, the data will be segmented by the 1108 system into 250-word blocks and more than one C block will be sent.

K. Software Constraints

Due to the complexity of the 1108 software system, it had been decided that the 6050/1108 interface diagnostic routine would remain in the 1108 system at all times. The way the system is mechanized calls for the first word after the sync word in a B block to be interpreted by the 1108 as a control word to bring in various diagnostic routines in the 1108. This word, designated XYXYXYXY in the B block illustration, is used in the following configuration to control the diagnostic:

77777777	Multiple-block diagnostic
01010101	Single-block diagnostic
77770000	Last diagnostic to be sent (causes job to dump in the 1108)

If these control words are used, the 1108 automatically brings in the diagnostic system and returns the data block sent to the 6050.

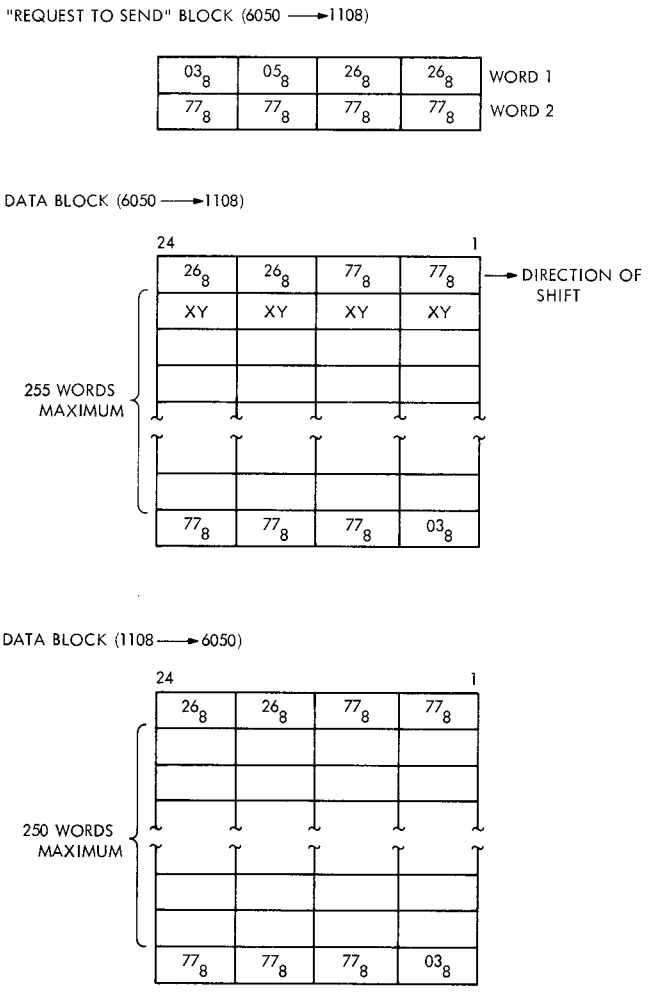

Fig. 5. Data block formats

III. Summary

The need to interface one computer with another is becoming more commonplace in the data processing world of today. The constraining factors in this design—the uncertainty of the location of the Univac 1108 and the different word lengths of the two computers—are typical of the constraining factors which would be encountered in the interfacing of other types of computers. These factors were successfully integrated into the design for this system. The approach used here, if not the actual design, may be usable in the interfacing of other computer systems.

The successful completion of this project will further enable the DSN Mark IIIA simulation center to simultaneously simulate two spacecraft and three DSSs in support of *Mariner* Mars 1971 and *Pioneer F* missions.

Reference

1. Polansky, R. G., "DSN Mark IIIA Simulation Center Development," in *The Deep Space Network*, Space Programs Summary 37-65, Vol. II, pp. 94–96. Jet Propulsion Laboratory, Pasadena, Calif., Sep. 30, 1970.